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IS 1649 (1962): Code of practice for design and construction of flues and chimneys for domestic heating appliances [CED 13: Building Construction Practices including Painting, Varnishing and Allied Finishing]



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“Knowledge is such a treasure which cannot be stolen”



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IS : 1649 - 1962

*Indian Standard*

CODE OF PRACTICE FOR DESIGN AND  
CONSTRUCTION OF FLUES AND  
CHIMNEYS FOR DOMESTIC HEATING  
APPLIANCES

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BUREAU OF INDIAN STANDARDS  
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG  
NEW DELHI 110002

# Indian Standard

## CODE OF PRACTICE FOR DESIGN AND CONSTRUCTION OF FLUES AND CHIMNEYS FOR DOMESTIC HEATING APPLIANCES

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## *Indian Standard*

# CODE OF PRACTICE FOR DESIGN AND CONSTRUCTION OF FLUES AND CHIMNEYS FOR DOMESTIC HEATING APPLIANCES

### 0. FOREWORD

**0.1** This Indian Standard was adopted by the Indian Standards Institution on 4 June 1962, after the draft finalized by the Building Construction Practices Sectional Committee had been approved by the Building Division Council.

**0.2** The satisfactory and safe conduction of products of combustion from domestic appliances by means of flues and chimneys is an essential requirement for healthy and comfortable living in a building. The construction of flues and chimneys has to take care of several aspects like fire safety, structural strength, thermal insulation, waterproofing and prevention of condensation. The subject has interested builders to have a systematic study for more than a century. Several improvements have occurred as a result of this long experience and this standard is intended to give guidance in this respect to builders.

**0.3** The Sectional Committee responsible for the preparation of this standard has taken into consideration the views of builders and technologists and has related the standard to the building practices followed in the country in this field. Due weightage has also been given to the need for international co-ordination among standards prevailing in different countries of the world. These considerations led the Sectional Committee to derive assistance from the following standards:

B.S. CP : 131 : 101 : 1951 CODE OF PRACTICE FOR FLUES FOR DOMESTIC APPLIANCES BURNING SOLID FUEL. British Standards Institution.

B.S. 1181-1961 SPECIFICATION FOR CLAY FLUE LININGS AND CHIMNEY POTS. British Standards Institution.

**0.4** Wherever a reference to any Indian Standard appears in this code, it shall be taken as a reference to its latest version of the standard.

**0.5** Metric system has been adopted in India and all quantities and dimensions in this code have been given in this system.

**0.6** For the purpose of deciding whether a particular requirement of this standard is complied with, the final value observed or calculated,

expressing the result of a test or analysis, shall be rounded off in accordance with IS : 2-1960 Rules for Rounding Off Numerical Values (*Revised*). The number of significant places retained in the rounded off value should be the same as that of the specified value in this code.

**0.7** This code is intended chiefly to cover the technical provisions relating to design and construction of flues and chimneys, and it does not include all the necessary provisions of a contract.

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## 1. SCOPE

**1.1** This code deals with the design and construction of flues and chimneys for domestic appliances that are worked by natural draught.

**1.1.1** The flues and chimneys may be built either of clay-brick, stone or concrete block masonry; or of concrete cast *in-situ*; or of terra cotta, metal or asbestos cement pipes.

**1.1.2** The flues and chimneys may be free standing, or may form an integral part of a building or a structure, or located in a shaft accommodating plumbing units.

**1.2** The domestic appliances covered in this standard are described in Appendix A. The provisions of this standard for construction of flues and chimneys are applicable only if the heat range is within the limits indicated in A-2 and A-3.

## 2. TERMINOLOGY

**2.0** For the purpose of this standard, the following definitions shall apply (*see also* Fig. 1).

### 2.1 General

**Condensate** — The deposit (liquid or solid) produced when the flue gases are cooled below their dew-point.

**Corbel** — A unit cantilevering from a wall surface to form a bearing.

**Dew-Point** — The temperature at which, during the cooling of the flue gases, some of their products begin to deposit.

**Diluent Air** — Air admitted to a chimney to dilute the flue gases.

**Draught** — The aeromotive force producing the flow of the gaseous products of combustion up through the chimney.



*Drip* — The outer edge of a recess formed on the underside of a projection from a wall, to facilitate the fall of rainwater clear off the wall.

*Flaunching* — The weathering formed in mortar at the top of a chimney or base of a chimney pot.

*Mud-Pluska* — Roof-finish with soil mixed with binding and reinforcing ingredients.

*Offset* — A recessional set-back of the walling material.

*Oversailing* — A projection or set-forward of the walling material.

*Plumbing Unit* — An assemblage of prefabricated pipework.

*Weathering* — An inclined surface formed to enable rain-water to drain off; also the material, if applied, which forms it.

## 2.2 Flue and Chimney Parts

*Arch Bar or Chimney Bar* — A metal bar, usefully of wrought iron or steel, providing permanent centering for a fireplace arch or for the wall over a fireplace opening. The ends of the bar are said to be 'caulked', if they are split and turned to form a holdfast.

*Baffle* — A contrivance in a stove or a furnace for interrupting the natural course of the flue gases.

*Chase* — A grooved cut into the chimney face to receive flashings, etc.

*Check-Draught Damper* — A device in the flue pipe connecting an appliance to a chimney, the opening of which permits the entry of air, thus reducing draught.

*Chimney* — A structure enclosing a flue or flues.

*Chimney Breast* — A projection beyond the thickness of a wall to contain fireplaces and flues.

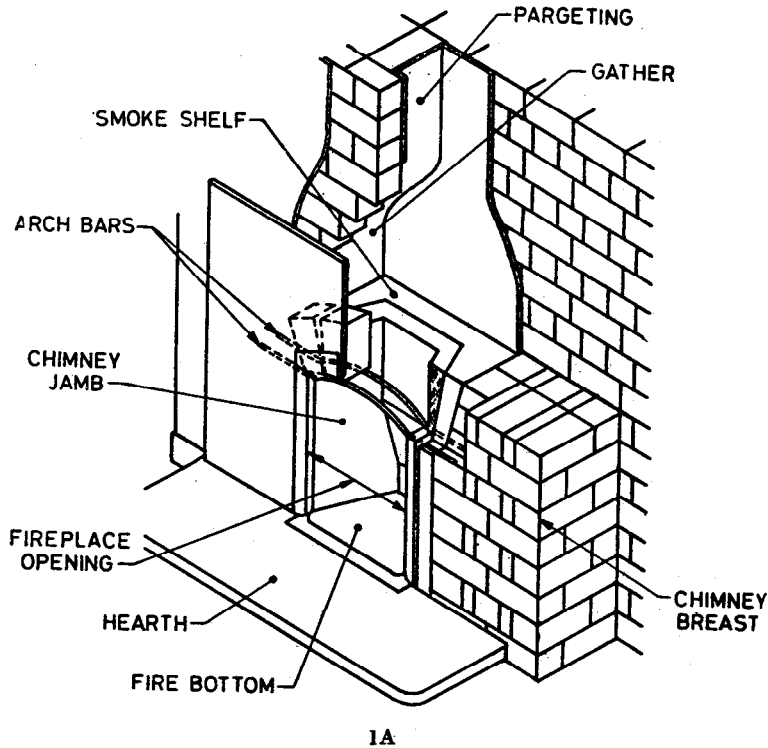
*Chimney Jamb* — The walling at the side of a fireplace recess.

*Chimney Pot* — An earthenware flue terminal to a chimney.

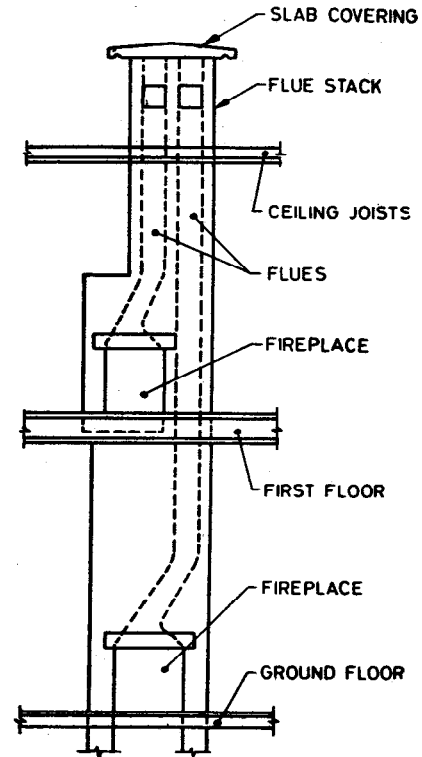
*Chimney Shaft* — That part of a chimney containing a single flue which rises above the roof of a building or, in the case of an isolated chimney, from the ground.

*Cowl* — A specially shaped flue terminal, with or without a revolving head, intended to improve the draught of a flue.

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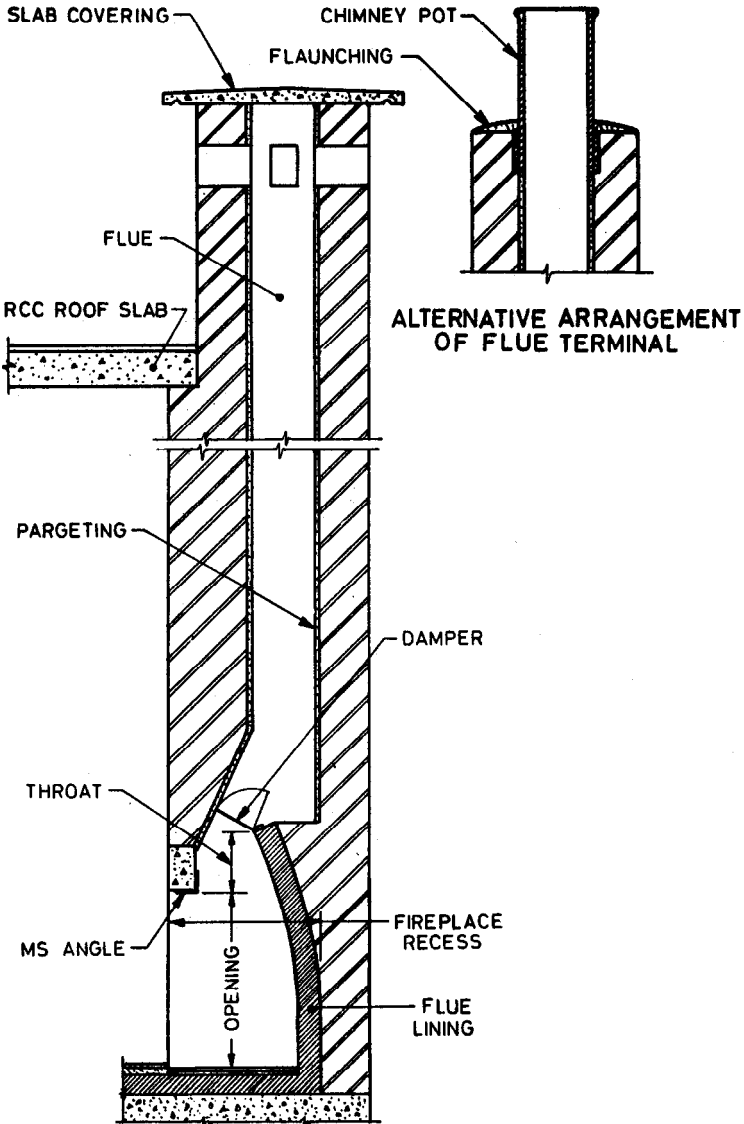
1A



1B

When the opening of the fireplace is flat on top, an MS angle may be used to support the bricks (see Fig. 1C)

FIG. 1 TYPICAL DETAILS OF FIREPLACE (Contd)



1C

When the opening of the fireplace is arched on top, an arched steel bar may be used to support the brick arch (see Fig. 1A)

FIG. 1 TYPICAL DETAILS OF FIREPLACE

*Fireplace* — A space at or in a wall or chimney breast appropriated to a fire.

*Fireplace Recess* — A space formed in a wall or chimney breast into which an appliance may be placed and from which a flue leads.

*Flue* — The duct through which products of combustion pass.

*Flue Stack* — That part of a flue or chimney which rises above the roof of a building.

*Free Standing Chimney* — A chimney or the portion of a chimney which is not bonded throughout its height to the main structure.

*Gather* — The contraction over a fireplace recess to reduce it to the size of the flue.

*Nozzle* — A flue outlet of a closed appliance.

*Smoke Shelf* — A horizontal ledge formed at the back or side of the throat of an open fire.

*Terminal* — A built-up or prefabricated unit forming the outlet end of a flue.

*Throat* — That part of the flue, if contracted, which lies between the fireplace and the main flue or smoke chamber; similarly, in a closed appliance, the contracted space from the fire box.

*Withe* — ( *Or Midfeather* ) — A partition between adjacent flues in a chimney.

### 2.3 Operations, Finishes and Equipments

*Core* — A sack filled with soft material to fit snugly in the flue, drawn up as the work proceeds.

*Coring* — Freeing, by the use of a core, the inside of a flue from obstructions and mortar droppings.

*Cripple* — A board to prevent mortar dropping down a flue. It is drawn up the flue as the work proceeds.

*Grip Coat* — An undercoat required with some vitreous enamels.

*Pargeting* — Rendering on the faces of a flue to form a smooth surface.

*Rendering* — One or more coats of mortar or plaster on brick, concrete or stonework, or the act of laying such a coat or coats.

*Spalling* — Breaking-off in fragments or chips.

### 3. NECESSARY INFORMATION

**3.1** For efficient planning, design and construction of the work, detailed information with regard to the following shall be furnished to those responsible for the work:

- a) Particulars of the locality and exposure of the site and of the chimneys;
- b) Proximity of trees and tall buildings;
- c) Direction of the prevailing winds;
- d) The disposition of doors and windows and other openings in relation to position of the fireplaces;
- e) Possible subsequent installation of different types of appliances in place of the present ones; and
- f) Details from the manufacturers of appliances:
  - 1) Special requirements for fixing the appliance and its setting,
  - 2) Flue size required,
  - 3) Chimney height required,
  - 4) Insulation required,
  - 5) Air inlets and baffles to be provided, and
  - 6) Any other information required so far as the design of the chimney is concerned.

**3.2** All information given in 3.1 shall be made available to those who are responsible for the masonry work. Necessary drawings and instructions for planning the work shall be furnished.

**3.3** Arrangements shall also be made for the proper exchange of information between those engaged in masonry work and all those whose work will affect or will be affected.

### 4. MATERIALS, APPLIANCES AND COMPONENTS

**4.1 Masonry Materials, Damp-Proof Courses and Flashings** — These shall be as specified in the relevant Indian Standards, namely Codes of Practice for Brickwork, Stone Masonry or Hollow Concrete Block Masonry.

**4.2 Metal Flue Pipes** — Cast iron flue pipes shall conform to \*IS : 1729- Specification for Cast Iron Spigot and Socket Soil, Waste and Ventilating Pipes, Fittings and Accessories. Steel flue pipes shall conform

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\*Under preparation.

to the relevant Indian Standard, namely Steel Spigot and Socket Pipes and Specials for Water, Gas and Sewage.

**4.3 Asbestos Cement Flue Pipes** — These shall conform to IS : 1626-1960 Asbestos Cement Building Pipes, Gutters and Fittings (Spigot and Socket Type).

**4.4 Flue Linings** — These shall conform to the requirements specified in Appendix B.

**4.5 Chimney Pots** — These shall conform to the requirements specified in Appendix C.

## **5. DESIGN CONSIDERATIONS**

**5.1 General Principles** — A flue provides egress for the products of combustion from an appliance to the outside air and induces draught for the proper flow of air for the combustion of the fuel. It also serves to ventilate a room. The design of a flue should be determined by the duty it has to perform and the type of appliance which it may serve.

The most important general considerations of flue design are as given in 5.1.1 to 5.1.7.

**5.1.1** The cross-sectional area and the vertical height of the flue shall be considered in relation to the purpose of the flue and the type of appliance which it is to serve.

**5.1.2** In order to maintain the flue gas temperature, excessive heat losses shall be prevented and fortuitous leakage of air into the flue avoided.

**5.1.3** The resistance of the flue to the flow of gases shall be as low as possible. Rough internal surfaces, too flat gradients, abrupt changes of direction and reductions or enlargements of the flue shall be avoided.

**5.1.4** Terminals shall be so placed as to avoid zones of wind pressure which are likely to cause down-draught or, when this is impracticable, the design of the terminal shall be such as to minimize the risk of down-draught without unduly impeding the passage of the flue gases.

**5.1.5** An adequate supply of air is necessary to the room so that there is sufficient air available to pass up the flue.

**5.1.6** Flues on internal walls are always to be preferred to flues on external walls. If it is unavoidable to have a flue against an external wall, the thickness of the wall at the back of the flue shall be increased so that it will, in no case, be less than the general thickness of the external wall. Insulated flues and, in many cases, those with thick walls, retain more heat than those with uninsulated or thin walls of

similar material. Grouped flues are, in general, better than isolated flues. However, every fireplace must have its own flue and each flue shall be separated from its neighbours in the stack.

**5.1.7** Square flues facilitate easy sweeping with ordinary brushes and rods and will be adequate even when there is considerable restriction to area due to deposit of soot. Although 'one-brick' size for the flue is considerably larger than those necessary or desirable, it is generally accepted even for slow rate of combustion because of convenience in the construction *vis-a-vis* availability of materials. Ordinary domestic appliances installed in building will hardly require larger cross-sectional area of the flue than mentioned above and flues smaller than  $18 \times 18$  cm or circular flues of less than 18 cm dia are undesirable because of heavy soot that may be deposited from burning wood or bituminous coal.

The flues may also be of rectangular cross section (slit-type) with a clear width of the slit between 10 and 15 cm, and a length corresponding to that of the appliance, namely cooking range.

## **5.2 Fire Protection**

**5.2.1** Reference may be made to IS : 1645-1960 Code of Practice for Fire Safety of Buildings (General) : Chimneys, Flues, Flue Pipes and Hearths for requirements regarding fire safety.

## **5.3 Strength and Stability**

**5.3.1** Chimneys which are an integral part of a structure shall be so constructed that they can be expected to remain structurally sound and effective during the life of the building.

**5.3.2** Where the thickness of the chimney does not exceed that of the adjoining walls of the building, it will be sufficient to provide foundations similar to those of the adjoining walls. Where, however, the chimney is of exceptional size and height, the area of the foundations shall be obtained by calculation, and shall be such that the unit load on the soil from chimney will equal the unit load from the adjacent walls.

**5.3.3** Withes, whether of brick, stone or concrete shall be not less than 10 cm thick, including liners but excluding pargeting, and shall be properly bonded to the walls of the chimney.

**5.3.4** Where staying is necessary, the chimney shall be banded with a galvanized iron or bronze band, and closely clamped around the stack or shaft for the purpose of attaching the stays. Alternatively, an insert of bronze 6 mm thick having caulked ends shall be built-in as the work proceeds, the plan area of the insert being not less than one sixteenth

of the total plan area of the stack or shaft at the level at which it is embedded. Stays shall be of galvanized steel or some non-corrodible metal, soundly connected to the band or insert; they should be of such cross-sectional area as to form a rigid strut capable of sustaining a safe load equal to that on the area of the face of the stack or shaft opposite to the stay when acted upon by an equivalent wind pressure of 1.4 kg/dm<sup>2</sup>. Where no other anchorage is available, the stays should be bolted to a roof truss, purlin or hip rafter, but not to a common rafter or a jack rafter, and careful attention shall be paid to flashing around the stays where they pass through the roof covering.

5.3.5 Chimney pots shall be built into the stack or shaft to give an embedment of not less than 15 cm excluding the flaunching, or one quarter the length of the pot, whichever is greater. In calculating the amount of embedment, the length of any cowl or projection shall be added to the length of the pot.

#### 5.4 Protection Against Damp Penetration

5.4.1 In order to obtain a satisfactory draught, it is important that the wall immediately around the flue should be dry, and precautions shall be taken at the following locations:

- a) *Base of chimney* — To prevent damp rising from the ground, the damp-proof course of the main walling shall be carried through the chimney below the lowermost fireplace.
- b) *Intersection with roof* — Apart from the usual external flashings consisting of back gutter and flashing, stepped side-flashings, front-flashings and apron, etc, around the chimney, further precautions are usually required at the intersection of the stack or shaft with the roof as shown in Fig. 2.
- c) *Stack or shaft* — Severe conditions of exposure are inevitable and, therefore, the materials used shall be restricted to those which are known to weather well in wet and exposed situations, and particularly to those known to be unaffected by repeated freezing when wet.
- d) *Flue outlet* — Precautions shall be taken in order to minimize or prevent direct rain penetration to the flue (see Fig. 1), some commonly adopted precautions are:
  - 1) covering with slabs,
  - 2) covering with cowls, or
  - 3) covering with H-shaped pipes.

NOTE — The use of H-shaped pipes will be found advantageous. The covering appliance shall be detachable (see also 5.12.4).



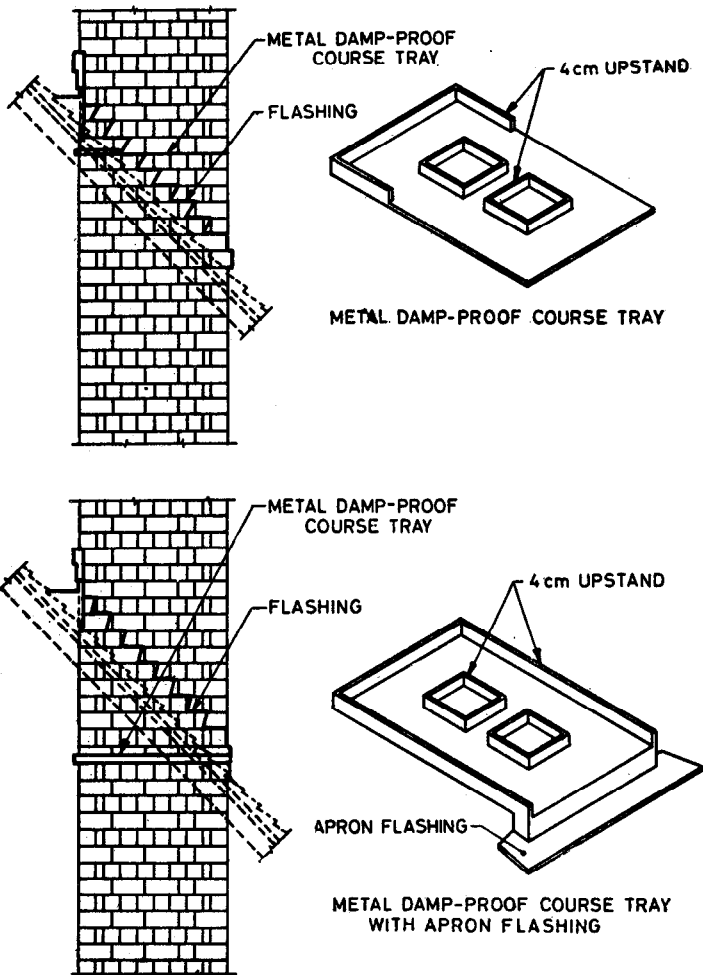


FIG. 2 DAMP-PROOFING AT JUNCTION OF BRICK CHIMNEYS WITH SLOPING ROOFS

- e) *External chimney* — When a chimney is on an external wall, especially when in an exposed position, the walls, unless they are cavity walls, may require protection from the weather by rendering or other suitable treatment.

## 5.5 Prevention of Condensation

**5.5.1** Condensation of moisture from the flue gases will occur if the temperature of the inner surface of the chimney falls below the dew-point temperature of the flue gases, and there may be consequent damage to the chimney and staining of the walls of the room. General experience leads to the following conclusions:

- a) With open fires, condensation is unlikely to occur, and no precaution is necessary.
- b) When domestic boilers and openable stoves are fitted to 20 cm diameter or one-brick wide square flues, it is highly desirable to take all practical precautions to avoid loss of heat.
- c) With domestic boilers and openable stoves served by chimneys of types other than those mentioned in (b) above, and with closed stoves and slow combustion cookers served by any type of chimney, the following precautions may be necessary:
  - 1) Air shall be admitted to the flue at a point about 1.8 m above the outlet from the appliance. The opening shall be not less than 30 cm<sup>2</sup> and not more than 90 cm<sup>2</sup> in area, and as the diluent air shall be warm, openings shall be in the room in which the appliance is located, and not in an outer wall where the air temperature is likely to be lower.
  - 2) A fireclay or other acid resisting flue lining shall be provided in the chimney, and if the lining is impervious to water, provision shall be made for draining away the condensate. Where liners are used primarily on account of condensation, a sealed air space may be provided between the liner and the chimney to give additional thermal insulation, and so reduce the possibility of condensation.

**5.6 Thermal Insulation** — Where excessive heat loss is likely, especially when slow burning appliances are used which tend to cause condensation, it may, in special circumstances, be necessary to provide heat insulation to the external walls of chimneys equivalent to that of one-brick thick brickwork.

**5.7 Sound Insulation** (*see* Fig. 3) — Where chimneys are placed back-to-back in cavity party walls, the cavity separating them shall be closed vertically at the junction of the chimney breasts and walls, and horizontally near the chimney head. In brick walls, the vertical closing shall be done by means of half-brick thick projection from one leaf built hard against a strip of asbestos millboard inserted

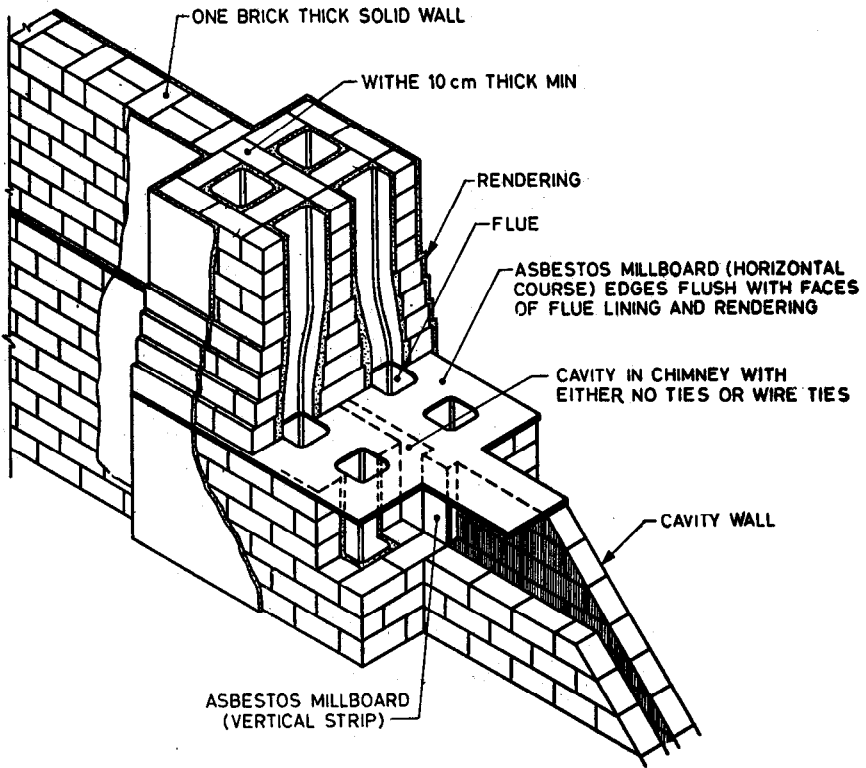


FIG. 3 SOUND INSULATION AT STACK IN HOLLOW PARTY WALLS AND METHOD OF CLOSING CAVITY

against the other leaf. The cavity, both in the chimney and in the wall, shall be continued into the roof space above the topmost ceiling, and a layer of asbestos millboard (holed for the flues and with its edges flush with the faces of the flue linings and the external rendering) inserted to close the cavity and form a complete horizontal break in the party wall. From this point, the flues shall be gathered to form a single stack and the wall carried up in solid construction.

### 5.8 Size and Height of Flues

**5.8.1** Flues required for normal domestic appliances rarely require a height more than about 4 m from consideration of draught, and this height is generally obtainable in an ordinary domestic building without excessive projection of flue stack at top.

**5.8.2** Additional height may be necessary to compensate for the effects of bends and inclined sections.

**5.8.3** Larger domestic appliances of more than 10 000 kcal/h will require height of flue to be designed for proper draught.

**5.8.4** The maximum height of flue shall be limited for any particular type of appliances but in practice this is not possible to follow or generally does not apply in domestic buildings provided the flue is otherwise correctly designed.

**NOTE**—The danger of explosion in case of closed appliances may be taken note of while considering flue sizes. Small area flue may have chance of explosive conditions, if fresh fuel is added to hot bed and the gas produced is not immediately ignited. This is likely to occur with bituminous fuel but it may also occur to a lesser degree in case of coke or hard coal.

**5.8.5** The internal dimensions of the flue for different appliances shall be as specified in Appendix A.

## **5.9 Fireplace Recess and Throat**

**5.9.1** Sufficient data is not available for judging the probable value of a smoke shelf, but it has been found that, in some circumstances, it helps to reduce the risk of smoke entering the room due to down-draught.

The throats of cooking ranges, stoves, etc, may normally be incorporated in the appliance.

**5.9.2** For most types of open fires, the throat, at its least cross section, shall not exceed 10 cm from front to back and, where possible, be of a width equal to about three quarters of the width of the grate. The entry to the throat shall be rounded and of a smooth surface, and the gather shall be tapered to meet the flue.

**5.9.3** The front wall of the chimney may be taken forward to form a hood over the hearth. In such case, the hood should be as sharp as possible so that it will deflect the smoke well into the flue.

**5.10 Bends and Changes of Section**—It is recommended that flues should be vertical whenever possible, but bends may be used in order to collect several flues into a common stack. A bend may reduce the splash of rain and the amount of soot which may fall on the hearth, but it tends to increase the resistance. The slope shall not be less than 45° with the horizontal, and preferably not less than 60°, and the junction shall be gradual so that resistance to the flow of the gases in the flue is kept as small as possible. There shall be no reduction in the area of the flue at the bend.

## 5.11 Height and Position of Chimneys Above Roofs

**5.11.1 Fire Safety**—Reference may be made to IS : 1645-1960 Code of Practice for Fire Safety of Buildings (General): Chimneys, Flues, Flue Pipes and Hearths for regulations in this respect.

### 5.11.2 Effect of Wind Pressure and Suction

**5.11.2.1** The height and position of a chimney in its relation to the roof, has a very important bearing on the proper functioning of the flue. Wind may affect the action of a flue in several ways. Wind pressure and suction are dependent not only upon the slope of the roof but also upon external influences such as the shape of the building, land contours, proximity of adjacent buildings, trees, etc, and although sufficient information is not available at present to enable any definite rules to be laid down for the correct positioning and height of chimneys, it should be recognized that in general, flue terminals shall not be placed in high pressure regions.

**5.11.2.2** To reduce the risk of inadequate draught where the discharge end of the flue lies within a distance of 2.2 m of the ridge of any adjoining roof or any adjoining structure, the height of the discharge shall be increased to not less than 0.6 m above the adjoining ridge or structure.

**5.11.2.3** The risk of down-draught may be reduced by using a high standard of flue insulation, with either a flue area of minimum size or a larger flue with damper arrangement to restrict the flow of flue gases.

**NOTE**—To heat the air in the flue and create draught initially, sometimes a burning oil lamp is kept over the shelf in the throat of the flue.

## 5.12 Terminals

**5.12.1** A projecting capping at the top of a chimney will assist in creating an area of low pressure at the flue outlet. Such a capping, weathered on top and provided with a drip, will also throw water from the pots and flaunching clear of the chimney walling immediately below, thus assisting to prevent saturation of the stack walls and minimizing soot stains on the surface. Cappings may be formed of any suitable material such as brick, stone, concrete or metal.

Where joints occur on the upper surfaces of cappings, suitable provision shall be made for the prevention of damp penetration either by flaunching or by the insertion of a damp-proof course.

**5.12.2** Pargeting shall be protected from rain and shali, therefore, not extend to the outlet; where this form of flue lining is employed, a clayware or other flue lining, or a chimney pot, shall be inserted to terminate the flue. Similarly, when liners are employed, the outlet

may be formed by a continuation of the liners or by a chimney pot. (Any liner or chimney pot shall extend at least 5 cm above the highest point of the weathering to prevent rain-water from being blown into the flue.)

**5.12.3** The outlet of a chimney pot shall be smaller than the area of the flue to increase the velocity of the flue gases and to minimize rain penetration. Where there are two or more flues in a common stack, and where high pots are not used, divisions shall be provided between the flue outlets in order to lessen the possibility of the products of combustion from one flue being drawn down another.

**5.12.4** In order to prevent direct rain penetration, a chimney may be finished with a flat slab or hood supported on piers, so that the smoke is emitted horizontally. The capping slab shall preferably be removable from the chimney for facility of cleaning the chimney frequently; for this purpose, use of sandstone slabs or precast concrete slabs may be advantageous. Weathering and a slightly projecting lining or pot shall be embodied in slab-type of terminal and the withes between the flue outlet shall be carried up to the underside of the slab or hood to safeguard against smoke being drawn into an adjacent non-operating flue. This form of terminal may help to reduce the risk of down-draught when a chimney is adjacent to tall buildings or trees or when the configuration of the ground warrants it.

### **5.13 Connecting Flue Pipes**

**5.13.1** A connecting flue pipe from an appliance entering a main flue shall not extend beyond the inside surface of the main flue.

**5.13.2** Where a flue pipe is carried vertically into a gather in the main flue, the pipe shall extend up to the minimum cross section of the gather.

**5.13.3** Where a free-standing appliance is placed in a recess and a concrete slab is used to support the chimney walls, the slab may be holed to take the connecting pipe from the appliance; any ledge formed above the slab on which soot may lodge shall be splayed. Normally, a soot door will be required at the bottom of all main flues.

**5.14 Separate Flues and Common Flues**— In general, a separate flue shall be provided for each appliance. Where, however, there are two adjacent appliances in the same room which are not operated at the same time and which have similar firing conditions, they may be connected to the same flue, but both flue pipes shall be provided with suitable dampers.

**5.15 Air Inlet to Rooms**— Adequate air for the proper working of a flue is normally supplied by infiltration at doors, windows, etc. Where

these are exceptionally air-tight, a special air intake may be required, and this should preferably be from inside the house. The inlet shall be placed in a position which will give the minimum discomfort to the occupants of the room, and will not cause any down-draught in the flue by creating a suction zone over the hearth.

## 5.16 Selection of Materials

**5.16.1** The materials used in the construction of chimneys for solid fuel-burning appliances shall be such that the construction is incombustible, durable, structurally robust, resistant to high temperature and sudden changes in temperature, and resistant to internal and external corrosion.

**5.16.2** Materials for lining flue shall have a reasonably smooth finish and shall be resistant to chemical attack by flue gases, and to spalling resulting from fire in the chimney. Bricks shall have a pargeting of either mud phuska or lime mortar but liners or precast components may replace pargeting and other traditional *in-situ* methods. Liners are desirable for stone chimneys. Other materials including concrete block, poured concrete, fireclay and cast iron, steel and asbestos cement pipes may be used as recommended in this code.

**5.16.2.1 Pargeting** — Traditionally, pargeting is of mud-phasuka which provides an absorbent soft lining. Current practice, however, is to use lime mortar gauged in similar proportions as for bedding brickwork, since use of mud-phasuka is not normally practical under present conditions. Cement mortar shall not be used. The mix for lime mortar used for pargeting will have to be decided based on the best local practice found satisfactory for the purpose. However, a mix of 1 : 3 (lime : sand) is considered to be generally satisfactory.

**5.16.2.2 Liners** — Flue liners are desirable in so far as they provide a smooth inner surface, facilitate sweeping and resist corrosion due to condensate. They shall be built in solidly or, if an air space is required, shall be held in place by at least three projections per section. It is recommended that fireclay liners shall be made with ogee or rebated joints to facilitate alignment during construction of the chimney and to eliminate cutting of the bricks which would be necessary with projecting sockets.

**5.16.3** The portion of a flue near a closed appliance is subject to extremes of temperature and, therefore, the first six feet of such an exposed flue shall be of cast iron, steel or other equally robust material. Asbestos cement and similar materials are not suitable.

**5.16.4 Masonry Mortars** — Mortar for masonry shall consist of mixes of cement and fine aggregate, lime and fine aggregate, or lime

gauged with cement and fine aggregate. The mix for cement-lime mortar may be 1 : 1 : 6 (cement : lime : sand) and for cement mortar 1 : 3 (cement : sand). In deciding on the mortar mix to be used, consideration shall be given to the best local practice and to any mixes that may have been used satisfactorily to deal with special conditions. In the case of fireclay flues lining only fireclay mortar shall be used for setting.

High alumina cement is generally used for special purposes only, for example resistance to chemical attack or where high early strength is essential.

**5.17 Jointing and Pointing** — The jointing or pointing of chimneys built of brick, stone or concrete units is important for the air-tightness of the flue. Jointing (that is, finishing as the work proceeds with the same mortar that is used for bedding) is to be preferred, as it leaves the mortar base undisturbed. It is advisable that the mortar used for pointing should be of adequate frost resistance and also, if possible, of approximately the same strength as the mortar used for bedding, but care shall be taken that it is not so dense as to prevent drainage of water from the walling materials as this would increase the risk of spalling due to frost action.

### **5.18 Provision of Soot Doors for Cleaning**

**5.18.1** All flues shall be accessible and provide a free way for the sweep's brush or flue brush.

**5.18.2** Soot doors are essential in all flues when it is not possible to clean the flue through the appliance. The frames shall be carefully built in and provided with tight covers.

**5.18.2.1 Soot door construction** — The outer casing and outer doors shall be made of galvanized or vitreous enamelled cast iron, and the inner door handles and the tongue of the turnbuckle of the outer door shall be made of mild steel.

**5.18.3** Arrangements shall be made so that the soot and dust removed can be collected with the minimum of mess. For this reason, it is advantageous to place soot doors externally, but in doing so consideration shall be given to the risk of increased heat loss. Such doors shall normally be below the connection of a closed appliance; where the door has to be above this connection, double doors shall be employed, the interspace being provided with a suitable incombustible insulating pad.

**5.18.4** With flue pipes having a smooth surface on the inside, serving all appliances other than open and closeable fires, there is the risk that a large amount of soot from the flue walls may fall and block the outlet



from the appliance. To overcome this contingency, the main flue shall extend downwards past the connecting flue (which should enter the main flue at right angles), and a soot door, which would be convenient also when sweeping the flue, may be provided at the bottom of the extension.

**5.18.5** Where soot doors are required to be placed in a room, it is recommended that a deep box frame shall be used so that the door may project about 3 cm from the finished wall to facilitate the collection of soot. Alternatively, a flush face may be arranged with the door so fashioned and hinged at the bottom as to form a chute with cheeks when lowered. Soot doors shall be conveniently placed, not too near the floor, and in positions to enable the cleaning brush to be used effectively. This is particularly important if the chimney has bends and lengths of inclined flue.

**5.18.6** The tarry deposit formed by burning wood, especially 'green' wood, is difficult to remove by ordinary sweeping and, therefore, when wood fuel is likely to be used, soot doors shall be provided at positions convenient for the removal of hard deposits.

## 5.19 Brick Chimneys

**5.19.1** In general, the height of a stack or shaft shall not exceed six times its least overall horizontal dimension or, in cases where it is adequately stayed, the height above the stay shall not exceed this amount. Where this height ratio is exceeded, the stack or shaft shall be designed to withstand the appropriate wind pressure estimated in accordance with IS : 875-1957 Code of Practice for Structural Safety of Buildings: Loading Standards with the condition that no tension in the brickwork shall be permitted except that a tension not exceeding  $0.7 \text{ kg/cm}^2$  may be allowed when the brickwork is in cement mortar of not less than 1 : 4 mix and the bricks have satisfactory adhesion with the mortar and all joints are thoroughly flushed up. No tensile resistance shall be relied upon in stacks or shafts built of dense pressed bricks nor at beds in which damp-proof courses occur where the damp-proof course is of material, such as lead, slate, etc, which will not allow the stipulated tensile stress.

**5.19.1.1** The top twelve courses of the brickwork shall be built in cement mortar.

**5.19.1.2** Where a fireplace is required on an upper floor without support from a chimney breast or piers below, the brickwork shall be supported by oversailing or corbelling, or by steel or reinforced concrete beams, or cantilevers. Where oversailing or corbelling is employed, the total projection of the brickwork above shall not exceed the thickness

of the wall below, and the projection of each course shall not exceed 5 cm.

**5.19.2** A damp-proof course shall be provided in chimneys at their intersection with the roof. With bricks of porosity not exceeding 25 percent it will generally be found sufficient to provide a damp-proof course just above the underside of the roof timbers at the back of the chimney stack or shaft, but further preventive measures against moisture penetration may have to be taken by vertical flashing or surface treatment to the exposed portion of the stack or shaft below the damp-proof course.

## **5.20 Stone-Masonry Chimneys**

**5.20.1** In chimneys dealt with in this code, temperatures above the level of the throat are unlikely to rise sufficiently, even during chimney fires, to cause damage to the building stone used. There are no special limitations on the choice of stone for this reason, but conditions of exposure above the roof and the risk of condensate and acid products of combustion make it desirable to use only stone known to withstand such exposure well.

**5.20.1.1** A masonry wall immediately behind an open-hearth fire shall be protected by a refractory fireback or be faced with firebrick, but, if for decorative reasons, stone is required, the choice is limited to sandstone. Granite, slate and limestone are unsuitable.

**5.20.2** The permissible height of a stack or shaft depends upon its construction and whether it has backing of brick or concrete, but, in general, this height shall not exceed six times its least overall horizontal dimension.

**5.20.2.1** The general suggestions for oversailing or corbelling and for beams and cantilevers shall be as stated for brick chimneys except that oversailing courses and corbels may project an amount equal to half the thickness of the flue wall immediately below the projecting course, provided they are bonded into the body of the work to a distance equal to at least twice their projection. Oversailing shall not be formed of uncoursed rubble and flint work.

**5.20.3** Liners are desirable for all types of stone-masonry chimneys to reduce the risk of staining and the effects of the products of combustion on some types of stone, and also to eliminate the risk of the possible dislodgement of fragments of stone by sweeping. Any form of pargeing is undesirable for this type of construction.

**5.20.3.1** Liners forming separate flues shall be accurately spaced to form withes; the space between, except where a sealed air space is required, shall be concreted or solidly filled with rubble and properly

flushed up with mortar as the work proceeds; strong cement concretes and mortars will be unsuitable.

## 5.21 Plain and Reinforced Concrete Chimneys Cast In-Situ

**5.21.1** Where the stack or shaft constructed of plain dense concrete has a height not greater than seven times its least overall cross-dimension, no investigation need be made for structural stability against wind. Where, however, this ratio of height to least horizontal dimension is exceeded, the cross section of the stack or shaft shall be such that the tension in the concrete does not exceed  $3.5 \text{ kg/cm}^2$  [ see also IS : 456-1957 Code of Practice for Plain and Reinforced Concrete for General Building Construction ( *Revised* ) ] when the exposed portion has to withstand the appropriate wind pressure calculated in accordance with IS : 875-1957 Code of Practice for Structural Safety of Buildings: Loading Standards.

**5.21.1.1** In designing concrete chimneys, sudden changes in the cross-sectional shape shall be avoided as they tend to cause cracking due to drying shrinkage, and thermal expansion and contraction of the chimney when in use.

**5.21.1.2** All reinforcement used in chimney construction shall have a cover of concrete of not less than 2.5 cm from any external face and from the face of the flue.

**5.21.2** For chimneys cast *in-situ* on outside walls, the surface of the concrete exposed to the weather shall be rendered with a mix in the proportion of 1 : 3 ( cement : fine aggregate ), or otherwise finished in such a manner as to prevent the penetration of driving rain. This recommendation also applies to all exposed portions of chimneys above the roof.

**5.21.2.1** A damp-proof course may not be necessary in chimneys of plain concrete provided with liners and rendered. In tall stacks or shafts, the structural resistance to wind pressure is important, and where a damp-proof course is desired, it shall be of slate bedded in cement mortar in order to provide a non-yielding joint, but no tensile resistance at the damp-proof course shall be allowed in calculating the stability of the chimney stack or shaft.

**5.21.3** Pargeting shall not be used for cast *in-situ* concrete flues.

**5.21.3.1** Flue liners may preferably be used for cast *in-situ* concrete chimneys, particularly as they conveniently form the shuttering for the concrete. The joints of the liners shall be solidly bedded and kept in true alignment during the placing of the concrete, and for this reason rebated or spigot and socket pipes are recommended.

## 5.22 Chimneys of Precast Concrete Units

**5.22.1** The free-standing portion of the chimney shall be limited in height so that no tension can occur when it has to withstand the appropriate wind pressure in accordance with the recommendations of IS : 875-1957 Code of Practice for Structural Safety of Buildings : Loading Standards unless continuous steel reinforcement is introduced and the stack or shaft designed as a reinforced concrete structure.

**5.22.2** When the concrete blocks are made from concrete vibrated to produce a dense mix capable of resisting a 20-cm head of water against percolation, rendering of exposed surfaces is not necessary; in other cases, exposed surfaces shall be rendered as recommended for cast *in-situ* chimneys, and damp-proof courses shall be provided. Owing to the practical difficulty of providing a damp-proof course through the upper part of the chimney with vertical reinforcement, the concrete above the roof shall be of a mix resistant to driving rain. Cement concrete of proportion 1 : 2 : 4, if properly mixed ( see IS : 456-1957 Code of Practice for Plain and Reinforced Concrete for General Building Construction (*Revised*), will be suitable for this purpose; where the workmanship cannot be ensured a denser mix shall be used.

**5.22.3** Where steel reinforcement is introduced into *in-situ* concrete filling of hollow blocks, the reinforcing bars shall be lapped 40 diameters, wired at the joints and suitably linked at intervals so as to cage the reinforcement around each flue.

**5.22.3.1** Link bars shall be accommodated in suitably shaped rebates or channels formed in the precast blocks, the links being solidly embedded in 1 : 3 cement mortar as a protection against rusting.

**5.22.3.2** Cantilever supports shall be suitably reinforced in accordance with the design.

## 5.23 Metal and Asbestos Cement Flues

**5.23.1** All metal and asbestos cement chimneys shall be stayed at intervals not exceeding either 16 times the internal diameter of the pipe or the length of each pipe section, whichever is the least. Staying and supporting is best effected at each joint.

**5.23.1.1** In no case should the appliance be used to support the chimney.

**5.23.2** Asbestos cement flue pipes shall not be used with open fires or appliances in which bituminous coal or long-flame fuels are used, nor where control of the fuel is not possible. Further, they are not suitable where the internal temperature in the pipe exceeds 260°C nor where there is direct flame impingement on the walls of the pipe.

**5.23.3** If a protecting sleeve of a flue pipe is supported by combustible material, an asbestos packing shall be inserted between the supporting clamp and the sleeve to insulate it from the combustible material.

**5.23.4** It is important that the joints should be airtight and that provision should be made in the fixing for the pipes to expand and contract in their length without damaging the joints. Where a flue is held by brackets, expansion shall be provided for length by allowing sufficient clearance in the joints themselves. In the case of flanged and similar joints when the chimney moves as a whole, there shall be sufficient clearance through the fastenings to permit this movement, and provision shall be made to take the whole weight of the chimney on the bottom support.

**5.23.5** Except where cleaning can be satisfactorily performed through the appliance, chimneys shall be provided with access openings at the base. Access openings of sufficient size and so arranged as to enable a flue brush to be inserted, shall be provided at all bends. The openings shall be fitted with airtight doors and shall be in such positions that the whole length of pipe may be readily swept

## **6. PROGRAMMING THE WORK**

**6.1** The time schedule shall take care of the following points:

- a) Construction of chimneys of bricks, stone or concrete shall necessarily be along with the main construction work of the building.
- b) Flue pipes shall be installed after the main construction work is completed, but requisite chases, openings, supporting stays, brackets and other allied items of the work shall be done along with the main work.
- c) Flue pipes and appliances and their installations in the building shall be co-ordinated with main construction work and the work of all the trades.
- d) Lagging shall be taken up while the pipes remain accessible.
- e) Chimney stacks and shafts shall be completed before the roof covering is laid; and covering of the flues shall be carried out before the scaffoldings are removed and the appliances fixed.
- f) During the course of construction, chimney walls adjacent to timber floors and roof members shall be properly rendered.
- g) The curing and maturing of the precast concrete blocks shall be ensured before bringing them to the site and using in the construction.

- h) Portland cement, whenever used in the construction, shall be given sufficient hardening period as specified in IS : 456-1957 Code of Practice for Plain and Reinforced Concrete for General Building Construction ( *Revised* ).
- k) A minimum of seven days' time shall be allowed after the flues are completed and before fires are lighted. ( This provision applies only in the case of repair works generally. )

## **7. STORAGE AND HANDLING OF MATERIALS**

**7.1** Masonry materials shall be handled and stored as specified in the relevant Indian Standards. Precast blocks shall be adequately cured before being transported.

## **8. CONSTRUCTION OF FLUES AND CHIMNEYS**

**8.1** Generally the construction shall be done as specified in the relevant Indian Standards for brick masonry, stone masonry, concrete construction, etc.

**8.2** In order to obviate unequal settlement, the chimney and any walling bonded to it shall be built to rise simultaneously.

**8.3** All joints shall be solidly flushed up with mortar.

**8.4** Pargeting shall be well worked into all joints and shall be slightly rounded at the corners.

**8.5** Liners shall be properly bedded and jointed so that they are not thrown out of alignment or fractured during the placing of surrounding walling. They shall be held in position by continuous contact with the chimney walls or, if an air space be required, shall be held in place by projections on the pipe or from the wall.

**8.5.1** Spigot-and-socket pipes shall be laid with the sockets pointing upwards; the joints shall be properly filled and pointed with gauged lime mortar as for bedding of brickwork. Plain butt joints shall be made as thin as possible and shall be struck flush so as to obviate the presence of ledges on which condensate and soot may lodge.

**8.6** Independent flue pipes with spigot-and-socket joints shall, except for external flues, be erected with the sockets pointing upwards. The spigot end shall not rest on the shoulder of the socket, but a small gap shall be allowed for expansion. Where an asbestos cement pipe is jointed to a cast iron pipe with the spigot of one entering the socket of the other, an all-round clearance is particularly desirable.

**8.6.1** Proper jointing material for flue pipes is essential. Surplus and extruded jointing material shall be removed from the internal surfaces

to avoid constriction and roughness of the flue, and this shall be done as construction progresses.

**8.6.2** Before erection, cast iron pipes and fittings shall be examined to see that they are free of moulders' sand and rough edges which, if left, encourage the collection of dust and soot deposits. The supports for a flue pipe, if fixed prior to the erection of the pipe, shall be correctly positioned.

## 8.7 Jointing

**8.7.1 Cast Iron Pipes**— Joints shall be made with asbestos fibre or string, well caulked to a distance of about 12 mm from the top of the socket and pointed with a fillet of cement mortar of mix 1 : 4, and finished smooth.

**8.7.2 Steel Pipes**— Steel pipes do not require any jointing material as they will be so made that one end is a tight push-fit over the other. Where they are finished with vitreous enamel, they shall not be spigoted and socketed, but jointed by connecting pieces.

**8.7.3 Asbestos Cement Pipes**— The annular space formed between the spigot and the shoulder of the socket should be partially filled with firmly caulked asbestos string, asbestos cord or a layer of plastic asbestos; flue-jointing compound shall then be worked in and the joint completed in cement mortar to a smooth finished chamber. A suitable filling material for jointing, that is commonly used, is hemp-soaked in neat cement-slurry.

**8.8** Supports for metal and asbestos cement flue pipes shall be built in as the work proceeds. The supports shall take the weight of each individual length of flue pipe. Except in the case of flanged joints, the supports shall be so located so that the socket of each pipe rests on the support.

**8.9** Gathers in brick and stone over the fireplace shall be formed by oversailing from the jambs, and both oversailing and offset courses shall be trimmed to suit the line of the flue.

**8.9.1** Where bends occur in plain concrete chimneys, the surrounding concrete shall be allowed to harden for not less than twelve hours before the construction of the remainder of the chimney proceeds.

**8.10** Withes of brick and stone shall be bonded in alternate courses to the external walls of the stack.

**8.10.1** Withes of *in-situ* concrete shall be cast integrally with the external walls of the stack.

## 9. PROVISION OF DAMP-PROOF AND SOUND INSULATION COURSES

**9.1** The bed upon which a damp-proof or sound insulation course is to be laid shall be carefully flushed up with mortar, and an even bed formed to obviate damage to the insulating material. The damp-proof or sound insulation course shall be protected from injury by boards or other suitable material if left bare after laying. Care shall be taken to ensure that the mortar or other material placed on top does not fracture or penetrate the course.

**9.2** Sound insulation courses shall extend from the face of the flue lining to the outside face of the chimney wall, including any rendering which may be applied.

## 10. WORK AT THE TOP OF FLUES AND CHIMNEYS

**10.1 Flaunching and Weathering** — Flaunching on the tops of chimneys and weathering on the upper surfaces of projecting courses shall be solidly formed and be trowelled to a sufficient angle to drain off water.

**10.2 Capping** — Cappings in stone, cast stone or precast concrete shall be accurately set so that their drips stand proud of the chimney walls; the cappings shall preferably be removable. Openings formed in cappings for chimney pots or flue linings shall provide a clearance of 12 mm all round the pot or lining; the gap shall be pointed in a mortar as for flaunching.

**10.2.1** Slates or tiles bedded on top of the flaunching as an additional protection, shall be bedded solid in the mortar flaunching. Metal coverings shall be securely fixed.

**10.3 Chimney Pots** — Care shall be taken to ensure that chimney pots when used are set vertically, in true alignment and to the required embedment. They shall be supported by the walls or on the flue liners. When round pots are fitted over square flues, a continuous seating shall be provided for them by slates or tiles or other suitable material built across the corners, the thickness of pargeting should be increased under the seating at the corners, and should be trowelled off to form a smooth gathering to the pot. After setting the pot, the brickwork or masonry shall be continued, the voids round the pot being filled and flushed up with mortar, and a fillet of mortar formed all round to prevent rain-water penetration.

**10.4 Sleeves and Hooded Caps for Metal and Asbestos Cement Flue Pipes** — Sleeves and special hoods for independent flue pipes shall be carefully fitted to ensure that all parts are rigidly fixed and all joints properly made.



## 11. CORING

**11.1** In order to free the flue from all mortar droppings or other obstructions which might adhere to the lining, the flue shall be cored during construction; it should not be delayed until the chimney is complete, or mortar droppings may have set hard and be difficult to remove.

**11.1.1** The core shall be composed of a sack, to which a rope is attached, filled with a resilient material so that it fits the flue properly. It shall be inserted at the base of the flue, and pulled through as the work proceeds. Where necessary, coring holes shall be left for inserting the core.

**11.2** As an alternative to coring, mortar may be prevented from dropping down a flue by means of a cripple which shall be drawn up and adjusted during the building of the chimney.

**11.3** When the chimney is complete, a core shall be drawn through the flue from the top to the bottom to ensure that all obstructions are removed.

## 12. INSPECTION AND TESTING

**12.1** During the construction of the chimney, frequent inspections shall be made to ensure that where bends occur, no reduction of the flue area is made, that all details such as throatings, smoke shelves, terminals, damp-proof courses, flashings, etc, are effectively carried out, and that the flue is kept clear of mortar droppings and other obstructions. The cap and the head of the chimney shall be inspected, also the final coring of the flue shall be undertaken, prior to the removal of the scaffolding.

**12.2** Before the completion of other constructional and decorative work, inspection of the chimney breasts shall be made to see that all requirements relating to the proximity of combustible materials have been observed.

**12.3** The appliances shall be installed and operated for a short period under appropriate normal working conditions, and any leakage of flue gases or other defects noted and remedied.

**12.4** As a rough test for satisfactory operation of the chimney, old gunny bags, paper or similar material may be burnt in the hearth of the flue to see whether the smoke finds its way up the chimney freely without obstruction under normal conditions of weather.

## 13. MAINTENANCE

**13.1** Chimneys built in accordance with the recommendations of this code shall, in ordinary circumstances, need little maintenance; but

periodical inspections should be made with a view to remedying, and arresting the development of any defect.

**13.2** In order to prevent the possibility of fire due to accumulation of soot, particularly in flues from appliances burning household coal, chimney flues shall be swept once in three months normally in the case of domestic chimneys.

## **A P P E N D I X   A**

*( Clauses 1.2 and 5.8.5 )*

### **SIZE AND HEIGHT OF FLUES FOR SPECIFIC APPLIANCES**

#### **A-1. GENERAL**

**A-1.1** Flues for open fires, closeable fires, openable stoves and all appliances designed for burning bituminous fuels and where the nature of the appliance to be used is not known when the flue is constructed, may be square, rectangular or circular in shape. Square flues shall not be less than one-brick length ( 20 cm for modular brick ) in size. Circular flues shall be of size not less than 20 cm diameter where it is certain that only smokeless fuel will be burnt, and not less than 15 cm diameter in the case of appliance rated not greater than 6 300 kcal/h. Rectangular flues shall be of width not less than 15 cm, and of length designed corresponding to the appliance served. The height of the flue shall be not less than 3.6 m.

#### **A-2. FLUES FOR BOILERS**

**A-2.1** Small domestic hot water supply boilers are particularly sensitive to heat loss and infiltration of air into the flue. They depend for effective operation on maintaining a relatively constant chimney ' pull ' ; boilers require a greater chimney pull than open fires.

**A-2.2** An efficient boiler will idle for long periods, during which time it passes little heat into the flue. This especially if wet rubbish is burned, will cause conditions which give rise to heavy, objectionable and structurally dangerous condensation. Flues for such conditions, therefore, shall be well insulated, structurally airtight and never placed in isolation on external walls.

**A-2.3** All domestic boilers may be used with one-brick size square flues.

**A-2.4** For small boilers up to capacity, say 6 300 kcal/h, flues of a minimum diameter of 10 cm may be used. Such flues can be swept only

with a flue brush and, therefore, if they exceed three metres in length, provision must be made for sweeping access every three metres in the length, or for sweeping from the top. Small flues such as this, shall not exceed some nine metres in total length. If bituminous fuel is likely to be used, it is preferable that the flues should be one-brick wide square section, or if circular, of 18 cm diameter.

**A-2.5** Medium sized domestic boilers of capacity, say from 6 300 to 12 600 kcal/h shall have flues of a minimum diameter of 15 cm. Provision for sweeping shall be made as described in **A-2.4** for small flues.

**A-2.6** Large sized domestic boilers of capacity, say from 12 600 to 25 200 kcal/h shall have flues of a minimum diameter of 20 cm.

### **A-3. FLUES FOR COOKER**

**A-3.1** Domestic cookers for use with bituminous fuels will require flues not less than one-brick wide square size, or if circular, of 18 cm diameter. Small domestic boilers are sometimes connected to cooker flues with satisfactory results, but the practice is undesirable. Appliances which can only be used with smokeless fuel can, unless prohibited by the makers, be used with a flue of a minimum diameter of 15 cm.

**A-3.2** Heat storage cookers pass very little heat into the flue, are fed only with smokeless coal, and produce only a small volume of flue gas. It is, therefore, very desirable that flues for these appliances be on an inner wall; if isolated or on an external wall where the heat loss is high, some measure of insulation shall be provided. Flue areas for these appliances shall, generally, be small with a minimum size of 10 cm diameter. Very long flues may not retain sufficient heat to induce a satisfactory draught and, therefore, heat from an adjoining flue of a regularly used boiler or similar appliances with a relatively high heat input to its flue is advantageous. Adequate access for cleaning hard sulphate deposits from the lower end of the flue shall be provided.

**NOTE 1**— The range of small domestic hot water supply boilers in common use is from 18 to 45 dm<sup>2</sup> of heating surface. These boilers are rated at from 170 to 300 kcal/dm<sup>2</sup>/h according to type and usage.

**NOTE 2**— A closed stove shall have a flue of the same size as that of a boiler of the same combustion rate. Flues containing bends which make them not easily accessible for cleaning, however, shall have a minimum diameter of 15 cm.

**NOTE 3**— Where the chimney is on an external wall of a building, there shall be the equivalent insulation of not less than half brick thick brickwork between the flue and the external air, but considerable benefit as regards draught may be derived if the lower part of the chimney is insulated to at least the equivalent of one-brick thick brickwork.

NOTE 4 — Where the height of a flue is stated, this shall be taken as the vertical measurement from the top of the fireplace opening, or the nozzle of the appliance, to the terminal outlet.

NOTE 5 — Where flues are exceptionally long, or where there is an unusually strong pull, check draught air inlets near the bottom may be helpful, but these shall be installed only after reference to the maker of the appliance.

NOTE 6 — A one-brick wide square ( $20 \times 20$  cm for modular bricks) flue in brickwork should be not less than  $19 \times 19$  cm between faces. Internal dimensions of liners are  $16.5 \times 16.5$  cm if square, or 20 cm diameter if circular.

NOTE 7 — Where the appliance will be used continuously, thick-walled flues of high thermal capacity are satisfactory but where intermittent use allows repeated cooling, insulated flues of low thermal capacity, which warm up rapidly, may be preferable.

## APPENDIX B

( Clause 4.4 )

### SPECIFICATION FOR CLAY FLUE LININGS

#### B-1. GENERAL

**B-1.1** The flue lining shall be manufactured from fireclay or terracotta. They shall be sound, free from visible defects and shall give a clear ringing sound when struck with a light-weight ( not exceeding 0.15 kg ) hammer. They may or may not be vitrified and may be glazed or unglazed.

#### B-2. SHAPE

**B-2.1** The flue linings may have any one of the following shapes:

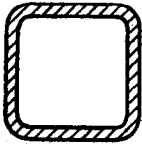
- a) Square on plan with rounded corners (for sizes 20 cm or larger) ( see Fig. 4A ).
- b) Circular on plan (for all sizes) ( see Fig. 4B ).

**B-2.2** The flue lining may be with either rebated or butt ends. In the case of sizes from 18 to 20 cm ( internal clear dimension ), socketed ends shall be provided ( see Fig. 4C ).

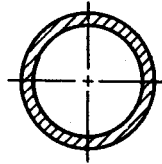
#### B-3. DIMENSIONS AND FIT

**B-3.1** The minimum thickness of the wall of the lining shall not be less than 2 cm.

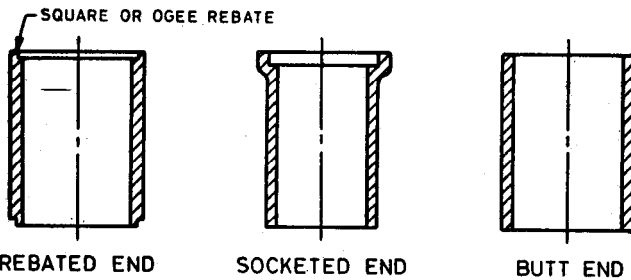
Straight units used in direct runs of flues shall be 30 to 40 cm long. Curved units for use in flue bends shall be so shaped that the angle contained by the ends are either  $22\frac{1}{2}^\circ$  or  $37\frac{1}{2}^\circ$  ( see Fig. 4D ).



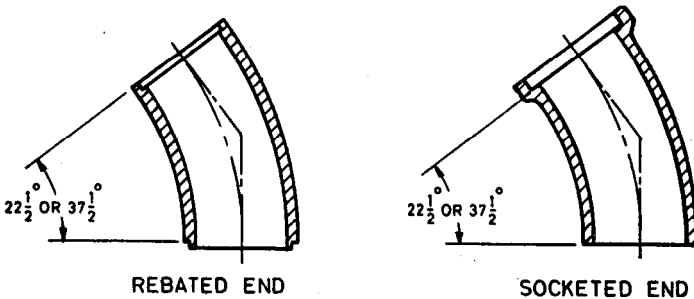
4A SQUARE SECTION



4B CIRCULAR SECTION



4C SECTIONS THROUGH STRAIGHT UNITS



4D SECTIONS THROUGH CURVED UNITS

FIG. 4 CLAY FLUE LININGS

**B-3.2** Rebate or socket provided at the end of each unit shall be such that it houses well the spigot end of the unit that will come next to it facilitating the required alignment of the lining for the flue.

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#### B-4. TRUENESS OF SHAPE

**B-4.1 Straightness of Walls** — Deviations from straightness in the wall of the flue lining shall be limited so that if a straight edge is placed along the length of the flue lining as shown in Fig. 5 the distance from the straight edge and the wall shall not exceed 6 mm at any point.

**B-4.2 Angles and Flatness of Walls** — Any variation from a right angle in the angle contained by any two adjoining walls shall be limited so that if a builder's steel square is placed against the angle as shown in Fig. 6 the maximum distance between the inner edge of the square and the flue lining shall be not more than 6 mm.

**B-4.3 Angle of Ends** — Any variation from a right angle in the angle contained by an end and the side shall be limited so that if a builder's steel square is placed against the angle as shown in Fig. 7 the maximum distance between the edge of the square and the flue lining shall be not more than 6 mm.

#### B-5. TOLERANCES

**B-5.1** The cross dimension, that is the width of a square lining measured as close to the adjoining size as the curvature of the corner will permit, or the diameter of a circular lining, shall not differ from the specified value for the particular flue lining by more than  $\pm 3$  mm.

**B-5.2** The maximum permissible tolerance for wall thickness shall be  $\begin{matrix} +5.0 \\ -1.5 \end{matrix}$  mm from the specified value.

## A P P E N D I X C

( Clause 4.5 )

### SPECIFICATION FOR CLAY CHIMNEY POTS

#### C-1. MATERIAL

**C-1.1** Clay chimney pots shall be manufactured from fireclay or terra cotta. These shall be sound, free from visible defects and shall give clear ringing when struck with light-weight ( not exceeding 0.15 kg ) hammer. They may or may not be vitrified and may be glazed or unglazed.

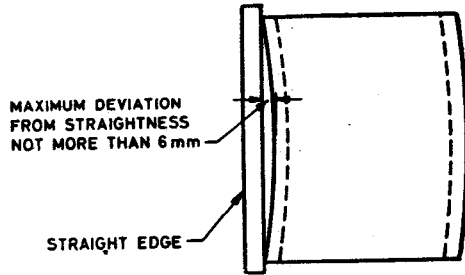
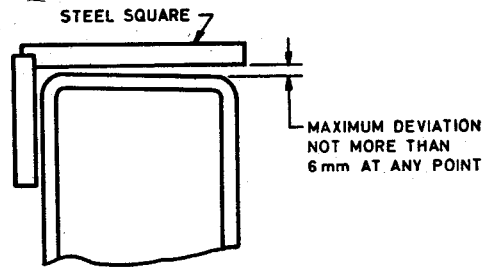
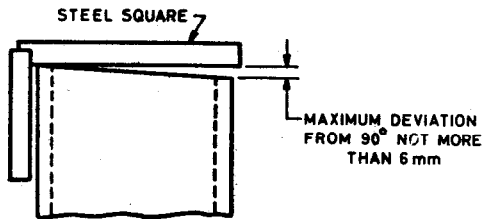


FIG. 5 METHOD OF CHECKING STRAIGHTNESS OF SIDE OF STRAIGHT EDGE



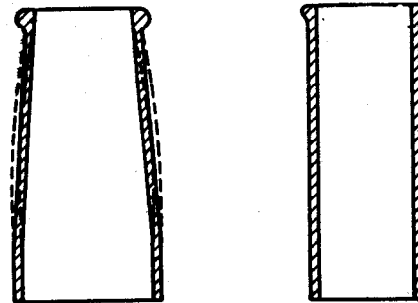
PLAN VIEW OF FLUE LINING OR POT BASE OF CHIMNEY

FIG. 6 METHOD OF CHECKING ACCURACY OF ANGLE BETWEEN WALLS



SIDE VIEW OF FLUE LINING

FIG. 7 METHOD OF CHECKING ACCURACY OF ANGLE BETWEEN JOINING EDGES AND WALL



8A TAPERED CHIMNEY POT

8B STRAIGHT CHIMNEY POT

FIG. 8 CHIMNEY POTS

## C-2. SHAPE

**C-2.1** The bottom of the chimney pot shall have the same section as that of the flue lining with which it is to be used ( *see B-2* ). Those which are to be used with linings of size 20 cm or more shall be tapered either in a uniform straight line or with an external belly from the full dimensions of the base to a circular top having internal diameter of 15 cm ( *see Fig. 8A* ). Circular chimney pots for linings of size less than 20 cm need not be tapered, and may have a uniform cylindrical shape ( *see Fig. 8B* ).

## C-3. BASE

**C-3.1** The base of the chimney shall be free from surface indentations or projections and shall be at right angles to the axis of the pots.

## C-4. DIMENSIONS

**C-4.1** The thickness of the wall of the chimney pot shall be not less than 12 mm.

**C-4.2** The lengths may be as specified, the usual range of values being from 30 to 90 cm. The maximum permissible tolerance for length shall be  $\pm 6$  mm in the case of lengths ranging from 30 to 40 cm, and  $\pm 12$  mm in the case of lengths exceeding 40 cm.

The maximum permissible tolerance in the cross dimension shall be  $\pm 3$  mm.

In the case of square base the diagonals shall be equal in length within  $\pm 6$  mm.



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